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Research Notes : Turkey : Research on growing possibilities of some determinate soybean varieties as a second crop in Cukurova, Turkey

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1) Double-crop soybean production techniques in Turkey.

Turkey is located between 36° and 42° N latitude. Syria, Iraq, and the Mediterranean Sea border Turkey on the south; the Black Sea on the north; Russia and Iran on the east; and the Aegean Sea, Greece and Bulgaria on the west.

The country has a total area of 77.9 million hectares. Approximately 36% is cultivated, 26% is pasture and meadow land, and the remaining 38% is forest or unproductive land (Tarimsal Yapi ve üretim, 1984).

Because of the suitable climate and soil conditions, it is possible to get more than one crop in a year in Aegean, Mediterranean, and southeast Anatolian regions of Turkey. Following the cereal harvest, soybean can be grown successfully as a second crop in the summer season. These regions have the most productive land of Turkey. Approximately 38% of the agricultural lands are irrigated with different sources of water. The main crops in the area are cotton and wheat.

After 10 years of research and four years of production observation, it is concluded that soybean can successfully be grown as a second crop with a satisfactory yield in these regions.

Soybean production possibilities as a part of a double-cropping system: In the Aegean, Mediterranean, and southeast Anatolian regions of Turkey, there are 1.3 million hectares of irrigated land. Most of these lands are used every year for cotton growing or cotton + wheat rotation. In the cotton + wheat growing system, wheat and barley are harvested from the end of May to mid-June. The fields are then left unplanted until cotton planting time (until next April).

In the southern and southeastern part of Turkey, wheat and barley farming is done on irrigated areas, approximately 303,000 hectares, Only about 20% of this land is used for double-cropping and 80% is left unplanted until the next season. Thus, 243,000 hectares of potential land is available for soybean farming. After wheat or barley harvesting, soybean can successfully be grown within 115-135 days in summer time (ölez et al., 1981).

According to preliminary studies, there are around 300,000 hectares of land suitable for soybean farming in Turkey. This area is expected to reach 500,000 hectares under the new irrigation projects.

The present status of double-cropped soybean production in Turkey: Soybean farming first began in Adana, Hatay, and içel provinces of Turkey in 1975, and in the following years spread out to K.Maras, G.Antep, Ş.Urfa, Diyarbakir, Antalya, Mugla, Aydin, Manisa, and Izmir provinces.

Soybean production in Aegean, Mediterranean, and Southeast Anatolian regions is given below (Tarimsal Yapi ve üretim, 1984).

Table 1. Soybean production in Aegean, Mediterranean, and southeast Anatolian regions of Turkey

Year	Area (ha)	Production (ton)	Yield (kg/ha)	Max. yield (kg/ha)
1980	122	180	1019	1500-2000
1981	17,000	15,000	882	1500-2000
1982	24,300	40,000	1650	2500-3000
1983	23,000	44,000	2170	3000-3500
1984	28,000	78,000	2780	4000-4500
1985	50,000	110,000	2200	4500-5000

As can be seen, the annual soybean production was 180 tons in 1980, then in 1985 it increased to 110,000 tons. Also, the yield per hectare increased from 1019 kg/ha to 2200 kg/ha in 1980 and 1985, respectively. The maximum yield was 1500-2000 kg/ha in 1980 and it also increased to 4000-4500 kg/ha in 1985. More than 90% of the total planted areas were double-cropped.

Soil preparation: In the double-crop soybean growing area, wheat is harvested from late-May to the middle of June. The wheat straw is burned before tilling on approximately 50% of the double-crop acreage. Usually, extremely dry soil conditions that existed after wheat harvest make it necessary to irrigate prior to seedbed preparation. Seedbed preparation consists of chisel plowing and then disking or of a two-diskings operation. After the final disking, a "cultipacker" type implement is used to level and firm the soil. Less frequently, farmers prepare the soil for planting and then irrigate after planting.

At this time, Turkish researchers are investigating the use of minimum tillage as a double-crop soybean production tool, but the necessary equipment is not currently available to the farming public.

Inoculation and fertilization: Soybean is a new crop for the Aegean, Mediterranean, and Southeast Anatolian regions of Turkey. Since the soil does not contain sufficient *Rhizobium japonicum* at planting time, seed inoculum must be used. The majority of this inoculum must be imported because of insufficient production in Turkey.

For double-crop soybean production, 40 kg of N and 60-80 kg P_2O_5 per hectare are used. This fertilizer is usually broadcast and then disked in prior to planting. Sometimes farmers apply an additional 20-40 kg N per hectare just before the first irrigation (full-bloom stage).

The Turkey soils are high in potassium; therefore K_2O fertilization is not necessary. In Turkey, the soil pH ranges from 6.5 to 7.5. Even though iron chlorosis has been observed on some high alkaline soils, the addition of iron fertilizer is uncommon.

<u>Soybean varieties and planting</u>: The growing season available for double-crop soybeans ranges from 115-135 days, depending on location. For this reason, Maturity Groups II, III, and IV varieties are grown. Widely used varieties include: Amsoy 71, Calland, A 3127, A 2575, Mitchell, Mitchell 450, Mitchell 410, L 4106 and L 4207. Mitchell 450 and L 4106 also may be used successfully as double-crop varieties if planted no later than June 20. Amsoy 71 and A 2575 are the only varieties that can be successfully grown after July 1.

Double-crop soybeans are typically planted from June 1 to July 7. Planting soybeans after July 7 is not recommended. Soybeans planted after this date suffer severe yield reductions and cause problems with harvest and drying.

Soybeans are planted at an intra-row distance of 2 to 4 cm in 40 to 70 cm rows depending on variety and time of planting. Row widths of 60 to 70 cm are common in early plantings, while narrower row widths (40 to 50 cm) are used in later plantings. The planting depth is 4 to 5 cm depending on soil moisture.

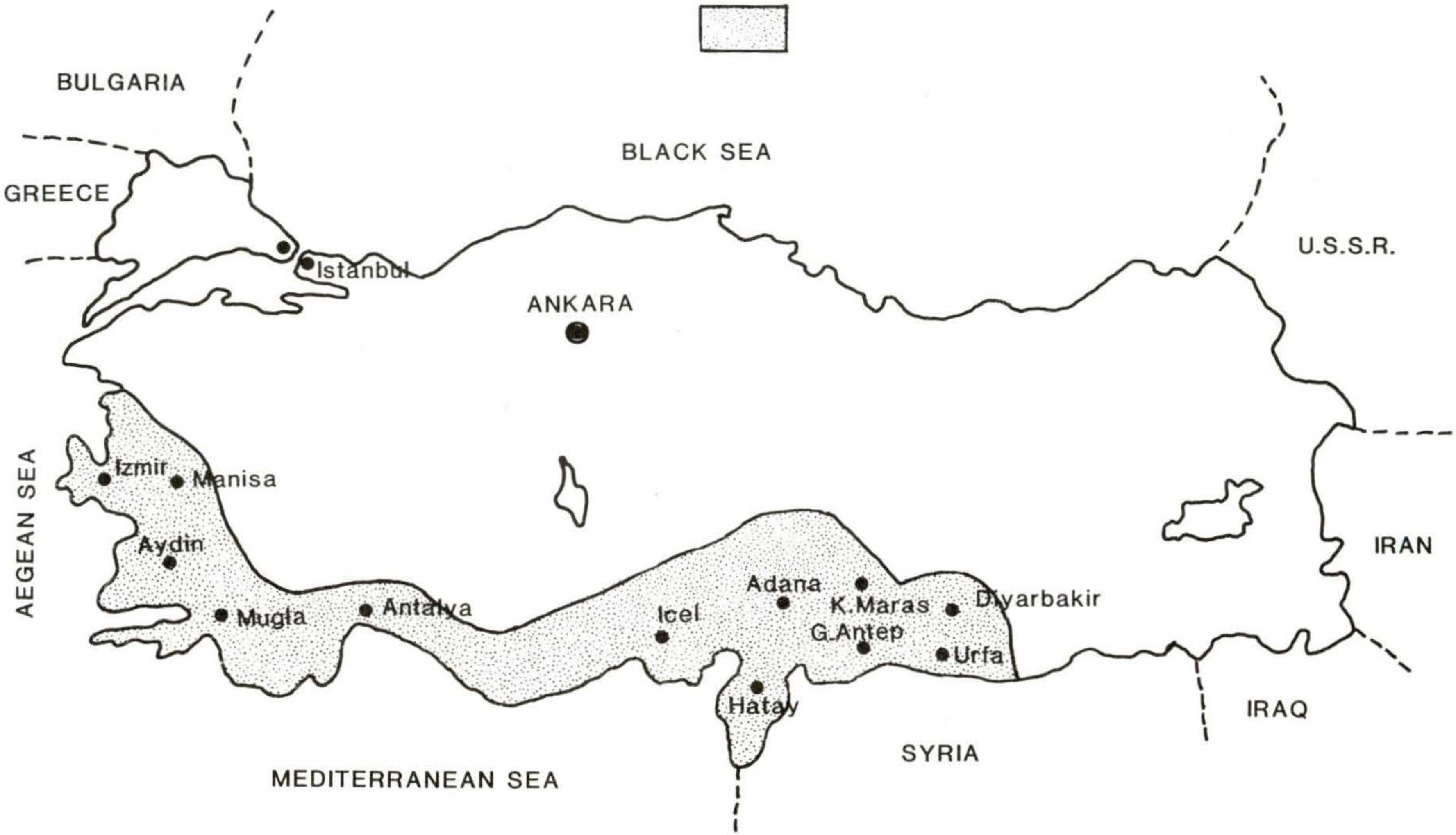
Cotton planters are commonly used to plant soybeans in Turkey. This results in many cracked and otherwise damaged seeds. Seeding rates range from 70 to 120 kg/ha depending upon the row width. No insecticides or fungicides are used at the time of planting.

Table 2. Performance of registered double-crop soybean varieties at four locations in Turkey in between 1976 and 1984 (Arastirma özetleri, 1984)

	Days to maturity				Yield (kg/ha)			
Varieties	Adana	Antalya	Izmir	Diyar-bakir	Adana	Antalya	Izmir	Diyar-bakir
Amsoy 71	97	95	97	103	3790	3473	3610	1593
Calland	110	106	113	109	3205	3433	3535	1533
Mitchell 450	120	120	-	109	3100	3915	-	1500
L 4106	111	106	-	93	3917	3330	-	1040
Mitchell	110	106	117	110	2630	3557	3435	1407
Mitchell 410	110	110	-	-	3400	3370	-	-
Washington V	100	101	108	103	3110	4063	3245	1736
Shawnee II	97	97	99	98	3337	3817	3595	1760
A 3127	110	-	-	-	3620	-	-	-
A 2575	100	-	-	-	3140	-	-	-
Latitude	37°00'N	36°52'N	38°26'N	37°56'N				
Elevation	50 m	42 m	25 m	660 m				

TURKEY'S MAP SUPERIMPOSED ON THE U.S.A. MAP

A MAP OF TURKEY
AND
DOUBLE CROP SOYBEAN PRODUCTION AREA



Weed and insect control: Virtually all double-crop soybeans are grown under irrigation. Many weed species fluorish under these irrigated conditions. Most common weed species include: common lambsquarters, common purslane, Virginia buttonweed, Bermudagrass, green foxtail, broadleaf signalgrass, Johnsongrass, large crabgrass, barnyard grass and nutgrass. Generally, herbicides are not used, but some farmers use triflourin.

Soybeans planted in 60- to 70-cm rows are cultivated by tractor; however, narrower row widths must be cultivated by hand. Soybeans are typically cultivated 2 or 3 times during the growing season.

The major insect pest problem of Turkish double-crop soybean is the white fly (*Bemesia tabaci*). This is, however, not a serious problem, since all recommended varieties have white-fly resistance. In spite of varietal resistance, damage can occur in extremely late-planted soybeans due to the migration of white flies from the maturing cotton. In this situation, one or two applications of insecticide are used for control.

Bollworm, green stinkbug, corn leafworm, and two-spotted spiders also affect soybeans to a limited extent. One insecticide application is usually sufficient for control of these pests.

Irrigation: Double-crop soybeans are grown only under irrigation in Turkey. Soybean production without irrigation is not recommended, due to the extremely hot and dry growing season. Depending on location, three or four irrigations are used. The first irrigation is at full bloom and subsequent irrigations are at 15-day intervals up to 15 days prior to harvest. Omission of the last results in yield reduction of 20-25%.

The flat topography of the soybean growing area allows for the use of furrow irrigation. Sprinkler irrigation is uncommon.

Harvesting and drying: Although it varies according to planting times and varieties, double-crop soybean is mostly harvested from the end of September through October. In Turkey, soybean is harvested with conventional combines. For this reason, the seed lost during harvest is up to 15-20%.

Humidity in the harvested material is about 13-15%, and, if the seed moisture content is higher than 95%, the seeds are dried under natural conditions. In the autumn, it may be a problem if the rain comes early for late-planted soybeans.

Storing, marketing, and processing: After harvesting, dried soybeans are stored in ordinary storage. In Turkey, there are not any modern soybean facilities.

In Turkey, the soybean support price is announced by the government every year before planting time with guaranteed buying. The farmers sell their soybeans to government or private companies as soon as possible after harvesting, because most of the farmers have not any modern soybean storage. The soybean price in 1985 was 26 cents (USA) per kilogram.

Presently, in Turkey, soybean is grown for its oil, cake, and soybean meal used in animal nutrition. In soybean farming areas, oil-crushers have 600,000 tons soybean seed processing capacity in a year (Yaltir, 1980).

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H. Halis Arioglu

2) Research on growing possibilities of some determinate soybean varieties as a second crop in Çukurova, Turkey.

Çukurova region, located in 37°19'N latitude, extends from the Hatay province in the east to the içel province in the west; from the Mediterranean Sea in the south to the Tourus Mountains in the north. It has 1.2 million hectares arable land; 1.1 million ha of land is used for growing field crops. Çukurova region has the most productive land of Turkey. For this reason, more than 50% of the arable land is irrigated and main crops are cotton and wheat. Because of the suitable climate and soil conditions, it is possible to get more than one crop in a year in Çukurova region (Atakisi and Genç, 1975). In the cotton + wheat growing system, wheat is harvested from the end of May to mid-June. After wheat harvesting, soybean can successfully be grown within 115-135 days in summer time (ölez et al., 1981).

Many INTSOY (International Soybean Program) varieties were taken into research as a second crop and among these varieties 'Amsoy 71', 'Calland', 'Mitchell', 'Mitchell 410', L 4106, A 2575 and A 3127, observed to be suitable for the Çukurova region (Atakisi, 1978; Atakisi and Arioglu, 1980; Arastirma özetleri, 1986). More than 90% of the total soybean production of Turkey was produced in Çukurova region.

Planting high-yielding varieties besides employing cultural techniques to improve the yield potential of soybean in this region is important. The objective of this study was to find new suitable soybean varieties that can be grown as a second crop in Çukurova region.

Material and methods: This experiment was conducted as a second crop after wheat harvest in experimental field of the University of Çukurova, Faculty of Agriculture, in 1981 and 1982. In this research, sixteen soybean varieties ('Gail', 'Alamo', 'Desoto', 'Bay', 'Davis', 'Williams 79', 'Centennial', 'Celest', 'Imp. Pelican', 'Ufv-1', 'Essex', 'Crawford', 'Ware', 'Braxton', 'Foster', and 'Pk-73-94') which are taken from INTSOY and two local varieties ('Amsoy 71' and 'Calland') were used. The experimental design was randomized block with four replications.

The climatical data over the growing period in Adana in 1981 and 1982 are given in Table 1.

Table 1. The climatic data over growing period in Adana in 1981 and 1982[a]

	Temperature						Relative humidity (%)		Total rainfall (mm)	
	Maximum		Minimum		Average					
Months	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982
June	32.5	32.4	19.1	20.2	25.6	25.5	68.2	63.0	125.3	43.1
July	34.0	35.5	23.2	17.1	28.3	27.0	68.9	67.6	-	27.8
August	34.3	37.6	23.6	20.4	28.4	28.0	68.7	69.0	-	69.0
September	35.0	33.9	21.0	21.5	26.8	26.5	59.4	66.5	4.9	15.6
October	31.4	28.3	17.1	15.8	23.0	21.1	58.9	59.4	63.8	79.3

[a]Source: Meteorological Surveys of Adana.

The soil type of the experimental area is sandy loam and soil pH ranged between 7.5 and 7.8. The soil contains a high amount of lime. The soil organic matter is low (Özbek et al., 1974).

The seedbed was prepared with diskharrow after wheat harvesting. Fertilizer (200 kg ha^{-1} diammonium phosphate) was broadcast at the time of soil preparation to experimental area. The plot sizes were 2.8 x 5.0 = 14.0 m^2 and row spacing was 0.7 m. The soybean seeds were inoculated with *Rhizobium japonicum* and planted by hand the first week of June in both years. The seeding rate was 25 plants per m row and planting depth was 5-6 cm. After planting, all plots were irrigated to obtain a uniform emergence of stand. The experimental area was furrowed twice during plant development to control weeds; irrigation was applied by flood irrigation system four times. The plots were harvested by hand at different times when the varieties reached to maturity and threshed by a stationary plot thresher.

INTSOY methods were used to obtain data (Jackobs et al., 1984). The investigated characteristics are:

Days to maturity (days): Days from date of emergence to date when 95% of the pods were ripe.

Whitefly scale (1-5): The whitefly observations were made visually according to 1-5 scale (1 = very resistant, 5 = very susceptible) on middle of August in each plot.

100-seed weight (g): Weight in grams of 100 randomly selected seeds from dried, cleaned grain.

Oil and protein content (%): Oil and protein content were determined on the dry weight basis by a near-infrared light reflectance instrument in the Department of Agronomy at the University of Illinois.

Plant height (cm): Height in centimeters was measured from the ground surface to the top of the main stem at maturity.

Pod number (pods/plant): Mean number of pods per plant estimated from 29 plants.

The lowest pod height (cm): Height in centimeters was measured from the ground surface to the first pod of main stem.

Yield (kg/ha): Weight in grams in clean, dry grain from 5.0 m of two center rows which is a harvested area of 7.0 m^2. Yield per hectare estimated from plots yield in kilograms.

Results and discussion: In this study, growing period, whitefly resistance, 100-seed weight, oil and protein percentage, plant height, the lowest pod height, pod number, and seed yield were investigated. Data obtained from the research are summarized in Tables 2 and 3.

Table 2. Growing period, whitefly scale, 100-seed weight, oil percentage, and protein percentage data pertaining to soybean varieties

Varieties	Growing period (days)	Whitefly scale (1-5)	100-seed weight (g)	Oil (%)	Protein (%)
Gail	147	2	20.10	17.2	45.0
Alamo	175	1	13.04	16.5	43.9
Desoto	121	5	10.42	20.2	43.3
Bay	126	2	19.66	19.6	42.5
Davis	148	3	15.50	18.2	42.4
Williams 79	121	5	14.25	21.1	44.7
Centennial	151	2	14.42	17.2	44.7
Celest	143	5	15.99	17.9	45.4
Imp. Pelican	175	1	13.53	18.1	44.5
Ufv-1	175	1	12.99	18.3	43.5
Essex	126	1	17.16	18.5	44.9
Crawford	133	5	11.72	19.8	44.1
Ware	140	2	20.95	19.0	44.3
Braxton	168	1	17.31	19.6	41.8
Foster	168	1	14.44	18.6	44.1
Pk 73-94	173	1	13.57	17.3	42.5
Amsoy 71	103	1	16.38	19.9	43.0
Calland	110	1	20.49	19.4	44.6

The growing period for soybean varieties was varied between 121 and 175 days. 'Essex' and 'Bay' varieties can be grown as a second crop in the Çukurova region. The other varieties cannot be grown because they have a longer growing period than the required normal time period for the second crop in Çukurova region.

Table 3. Plant height, lowest pod height, pod number, and seed yield data pertaining to soybean varieties

Varieties	Plant height (cm)	Lowest pod number (cm)	Pod number (number/plant)	Yield (kg/ha)
Gail	99.80 g	21.96 defg	30.99 def	2682.5 b
Alamo	145.78 b	60.93 a	41.39 c	1593.3 f
Desoto	87.95 h	15.63 hi	29.33 ef	974.6 h
Bay	111.03 ef	22.78 defg	27.43 fg	3051.9 a
Davis	118.64 de	21.06 efgh	51.90 a	2576.5 bc
Williams 79	90.71 h	13.29 i	31.00 def	1060.8 h
Centennial	112.10 de	22.48 defg	38.74 c	2056.1 d
Celest	91.03 h	35.76 c	21.38 g	1118.8 gh
Imp. Pelican	157.34 a	42.30 b	43.71 bc	1157.9 gh
Ufv-1	161.06 a	41.88 b	49.47 ab	1660.0 ef
Essex	89.15 h	21.09 efgh	40.16 c	3127.1 a
Crawford	103.30 fg	22.40 defg	27.81 fg	1405.6 fg
Ware	75.58 i	17.20 ghi	23.50 fg	1947.9 de
Braxton	137.03 c	26.46 de	28.65 fg	2139.4 d
Foster	120.18 d	27.63 d	36.75 cde	1670.8 ef
Pk 73-94	116.41 de	23.50 def	50.36 ab	2104.8 d
Amsoy 71	102.35 g	15.95 hi	37.20 cd	2246.7 cd
Calland	100.86 g	19.44 fgh	30.15 def	2825.8 ab
EGF (5%)	8.58	5.76	7.62	338.40
CV (%)	7.71	22.16	21.62	17.35

Alamo, Imp. Pelican, Ufv-1, Essex, Braxton, Foster, and Pk 73-94 soybean varieties were resistant to whitefly, while Desoto, Williams 79, Celest, and Crawford varieties were very susceptible and the others were moderately resistant.

Mean value of 100-seed weight was, in turn, found to be between 10.42 g and 20.95 g for Desoto and Ware, respectively. The average percentage of oil content of 16 varieties tested varied between 16.5% for Alamo and 20.2% for Desoto. The average percentage of protein content was highest in Celest (45.4%) and lowest in Braxton (41.89%).

The average plant height was determined between 91.03 cm and 157.34 cm and the lowest pod height ranged between 13.29 cm and 60.93 cm. The lowest pod height was found higher in new varieties than in local varieties.

The average pod number per plant varied between 21.38 and 51.90 in tested soybean varieties. Pod number was highest in Davis and lowest in Celest.

The average seed yield per hectare was found between 974.6 kg and 3127.1 kg. Seed yield was highest in Bay (3051.9 kg/ha^{-1}) and Essex (3127.1 kg/ha^{-1}) soybean varieties. The seed yield of these two varieties was higher than local varieties. A positive correlation was found between the yield, and 100-seed weight and pod number. However, there was a negative correlation between the yield, and oil and protein content, plant height, and lowest pod height. These findings are in agreement with the results of Jackobs et al. (1984).

In conclusion, Bay and Essex soybean varieties can be grown as a second crop after wheat harvest in Çukurova region, Turkey.

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H. Halis Arioglu

3) Screening of some soybean varieties for resistance to whitefly (*Bemisia tabaci* Genn.).

There are approximately 70,000 hectares soybean planted area in Aegean, Mediterranean, and Southeastern Anatolian regions of Turkey. These regions have the most productive land of Turkey. The main crops in these areas are cotton and wheat. In these regions, soybean is planted as a second crop after wheat harvest. The major insect pest of double-cropped soybean in these regions is sweetpotato whitefly (*Bemisia tabaci* Genn., Aleyrodidae, Homoptera) which affects soybean and other field crops in Turkey (Çinar et al., 1985). The sweetpotato whitefly has been a very important insect pest since 1974 in Turkey (Şengonca and Yurdakul, 1975).

Whiteflies lay light-yellow, stalked eggs mostly on the underside of leaves. Nymphs are oval and depressed, pale to greenish yellow and 0.5 mm in size. Adults are small insects with yellow body and hialine wings covered with a white powdery wax; it is 1-1.4 mm in size. Injury to soybeans is caused both by nymphs and adults sucking sap from leaves. Whiteflies secrete abundant honeydew. This honeydew forms a suitable medium for the development of a dark sooty mold, which inhibits light penetration and reduces photosynthesis. In addition to injury due to feeding, whiteflies are potentially damaging as vectors of several important soybean viruses (Kogan and Herzog, 1980). Infestation of whiteflies is usually heaviest during the pod-filling period and can cause severe reductions in yield. Chemical control of the whitefly has proven expensive and ineffective (Özgür, 1986; Özgür and Şekeroglu, 1986). The objective of this research was to identify soybean varieties with resistance to whitefly.

Material and methods: This study was conducted as a second crop after wheat harvest in experimental field of the University of Çukurova, Faculty of Agriculture, in 1976 and 1986. The experimental design was a randomized block with four replications. One hundred and nine soybean varieties were screened in this study, mostly taken from INTSOY and several breeding companies.

The seeds were planted by hand on first week of June. The plot sizes were 2.8 x 5.0 m = 14.0 m^2 and row spacing was 0.7 m. The seeds were inoculated with *Rhizobium japonicum* and fertilizer (200 kg/ha^{-1} diammonium phosphate) was broadcast uniformly over the entire experimental area just prior to soybean planting. Insecticide was not used for whiteflies over the growing period. Since whiteflies were very abundant, no artificial infestation was made. The whitefly observations were made visually according to a 1-5 scale (1 = very resistant, 2 = resistant, 3 = moderately resistant, 4 = susceptible and 5 = very susceptible) in mid-August.

The data for whitefly resistance are presented in Table 1.

Results and discussion: Among the selected varieties, numbers 1-15 were tested in 1976-77, numbers 16-31 in 1978-79, numbers 32-53 in 1981-82, numbers 54-67 in 1982-83, numbers 68-83 in 1983-84, numbers 84-100 in 1984-85 and numbers 101-109 in 1985-86.

Out of 109 soybean varieties tested, 42 varieties were found to be very resistant (1), 25 resistant (2), 16 moderately resistant (3), 14 susceptible (4), and 12 very susceptible (5).

Table 1. The results of screening some soybean varieties for whitefly (1976-1986)

No.	Varieties	Days to maturity	Whitefly scale (1-5)	No.	Varieties	Days to maturity	Whitefly scale (1-5)
1	Amsoy 71	95	1	29	Steele	90	2
2	Beeson	95	1	30	Swift	79	4
3	Chippewa	98	4	31	Altona	73	3
4	Clark	98	5	32	IE	103	2
5	LC-1	98	5	33	Cyst-Co	100	3
6	Sfr-300	98	4	34	Cumberland	98	4
7	Dare	115	3	35	Washington 5	103	1
8	Davis	115	3	36	Victoria	103	3
9	Forrest	115	1	37	Bellati L-263	98	5
10	Mack	115	3	38	Bellati S.D.	98	5
11	Bossier	129	3	39	Shawnee	100	2
12	Bragg	129	4	40	Shawnee 2	98	2
13	Lee 68	129	3	41	Gail	147	2
14	Pickett 71	129	1	42	Alamo	175	1
15	282/2	129	2	43	Desoto	121	5
16	Columbus	113	3	44	Bay	126	2
17	Calland	105	1	45	Williams 79	121	5
18	Cuttler 71	103	2	46	Centennial	151	2
19	Evans	80	3	47	Celest	143	5
20	Franklin	107	3	48	Imp. Pelican	175	1
21	Mitchell	110	1	49	Uvf-1	175	1
22	Corsoy	110	2	50	Ware	140	2
23	Harcor	113	2	51	Braxton	168	1
24	Crawford	113	3	52	Foster	168	1
25	Elf	112	2	53	Pk 73-94	173	1
26	Hodgson	99	2	54	Lakota	89	1
27	Union	90	3	55	Essex	120	1
28	Williams	92	5	56	Hardin	99	2

continued ...

Table 1. Continued

No.	Varieties	Days to maturity	Whitefly scale (1-5)	No.	Varieties	Days to maturity	Whitefly scale (1-5)
57	Hodgson 78	89	2	84	L 4303	95	2
58	Amcord	97	1	85	L 4208	93	3
59	Corsoy 79	95	1	86	L 3665	95	1
60	Clay	89	1	87	L 4204	95	1
61	Kent	105	1	88	L 2330	91	4
62	Century	82	3	89	L 1771	82	4
63	Pixie	82	4	90	L 4404	90	4
64	Williams 82	82	5	91	L 1994	82	4
65	Fayette	80	4	92	L 1808	95	1
66	Pella	80	4	93	L 4209	97	1
67	Sparks	80	4	94	L 4256	83	5
68	Hark	99	1	95	L 4104	93	3
69	Proto	99	1	96	L 4207	95	2
70	Villis	99	2	97	L 4106	115	1
71	Lincoln	102	2	98	L 4206	96	1
72	Adams	104	1	99	Mitchell 450	120	2
73	Vickery	103	1	100	Mitchell 410	110	1
74	Banas	104	1	101	A 1937	88	1
75	Icr	90	2	102	A 2575	95	1
76	Comerto	115	2	103	A 2943	100	1
77	Clark 63	100	5	104	A 3127	105	1
78	Woodworth	90	5	105	Semu-4	103	1
79	2180	99	2	106	Semu-33	103	2
80	2877	102	1	107	Semu-31	100	1
81	3377	104	1	108	Semu-2	99	3
82	3105	103	1	109	Semu-62	96	1
83	1617	103	1				

Whitefly scale: 1 = very resistant
2 = resistant
3 = moderately resistant
4 = susceptible
5 = very susceptible

The resistant varieties (Amsoy 71, Calland, Mitchell, Mitchell 410, Mitchell 450, L 4106, L 4207, Washington 5, Shawnee 2, A 3127, A 2943, A 1937 and A 2575) were recommended for production and are now widely used. Since these varieties had high seed production, they were easily accepted by growers.

No relation was found between whitefly injury and growing period. Woodworth variety was very susceptible and Amsoy 71 was highly resistant, both of which had 90-day growing periods. Similarly, Desoto variety, with 120-day growing period, showed high susceptibility and Essex, with same growing period, showed high resistance. The injured varieties reached seed maturity very quickly and gave low yield, whereas resistant varieties yielded between 2.5 to 4.5 tons per hectare according to cultural practices.

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H. Halis Arioglu

4) Effect of cheese whey as a fertilizer on the increase of soybean nodules.

Cheese whey, a dairy by-product with an estimated world production of 72 million tons, is a polluter to the environment if it is not treated before disposal. Among some practical and simple uses of whey is the use of it as a liquid fertilizer, which was the case in the pastures of USA and many other countries in the 1960s (Ryder, 1980). Since whey contains 50-55% of the dry matter of whole milk, it is rich in organic carbohydrate, fat, and some proteins and inorganic matter (mineral matter) and also in mostly lactic acid bacteria; 3 tons of whey equals 1 ton of animal fertilizer.

The wonder-plant soybean is also becoming popular in Turkey. Soybeans, among their uncountable qualities, have the important quality of enriching the soil with nitrogen. Being a leguminosae, they fix the air N into the soil through the nitrogen-fixing bacteria in their nodules.

In this experiment, cheese whey was used as liquid fertilizer in soybean production. Its effect on increasing the number of nodules was more pronounced and important than on the increase of soybean production.

Materials and methods: In the experiment, 'Calland' variety soybean and cheese whey from the local state dairy factory were used. The composition of the whey was as in Table 1.

Table 1. The composition of cheese whey which was used for the experiment

Drymatter	Protein	Lactose	Fat	Ash	pH	Acidity
6.59%	1.3%	3.99%	0.75%	0.55%	6.4	6.8 SH

The experiment was carried out in the faculty experimental fields with 12 m^2 parcels each, as random block experimental design. Calland variety of soybean seeds treated with the usual microorganism were planted (60 x 5 cm) by hand. Cheese whey was given soon after the planting at 2, 4 and 6 tons/da (1000 m^2) rates, while control parcels received only 2-6 tons of water and represented "0 ton/da" samples. Soybeans were irrigated three more times during the growth period, but with only water.

Nodules were counted twice, once at the beginning of 50% flowering, and the second time at the beginning of 50% fruit development stages. Nodule counting was carried out according to "INTSOY" (Anon., 1981). Ten plants were chosen randomly from each parcel and used for counting. Active and passive nodules were also determined, again using the methods of INTSOY.

Statistical analyses have been applied to the figures and the results have been summarized in tables and figures.

Results and discussion: The results of soybean nodule counts at two different stages of development and the statistical analysis are given in Tables 2 and 3.

Table 2. Effects of whey as fertilizer on soybean nodules at 50% flowering stage and the statistical results

Whey applied	Number of nodules I.block	II.block	III.block	Mean	Mean as %
0 ton/da (control)	70	68	65	67.7	100
2 tons/da	178	158	141	159.	234.9
4 tons/da	168	132	210	170.	251.1
6 tons/da	135	139	243	172.3	254.5

Sources	D.F.	M.S.	F
Columns	2	170.1	1.3012
Treatments	3	7518.3	5.7514*
Error	6	1307.22	
Total	11		

$F_{3,6,0.05} = 4.76$

As can be seen in Table 2, the numbers of nodules have increased from 67.7 to 159, 170 and 172.3, with 2, 4 and 6 tons of whey per decar. These increases correspond to 234.9%, 251.1% and 254.5%, respectively, and are statistically significant, too.

Table 3. Effects of whey as fertilizer on soybean nodules at 50% fruit development stage and the statistical results

Whey applied	Number of nodules			Mean	Mean as %
	I.block	II.block	III.block		
0 ton/da (control)	178	186	159	174.3	100.0
2 tons/da	286	226	234	248.7	142.7
4 tons/da	378	258	263	299.7	171.9
6 tons/da	399	215	263	292.0	167.5

Sources	D.F.	M.S.	F
Columns	2	9649.0	5.4388
Treatments	3	9929.86	5.5971*
Error	6	1774.11	
Total	11		

$F_{3,6,0.05} = 4.76$

As is seen from the figures in Table 3, when the mean value of control groups is accepted as 100%, the increases in 2, 4, and 6 tons of whey-treated samples are 142.7%, 171.9% and 167.5%, respectively. The statistical analysis of these increases also proves to be significant.

The effect of whey as fertilizer on the increase of soybean nodules can be seen as second degree polynomial regression curves in Figure 1. Regression equations and R^2 values are also given in the figure and R^2 values of 0.966 and 0.994 indicates highly significant relationships.

Table 4. Effects of whey as fertilizer on the active-to-passive nodule ratios at the 50% flowering (A) and 50% fruit development (B) stages

Whey applied	Active-to-passive nodule ratios (as %)	
	(A)	(B)
0 ton/da (control)	70.6	90.3
2 tons/da	81.76	90.5
4 tons/da	77.70	85.8
6 tons/da	76.50	91.2

Figure 1. Effect of whey as fertilizer on the number of nodules at (A) 50 % flowering and (B) 50 % fruit development (2nd degree polinomial regression curves)

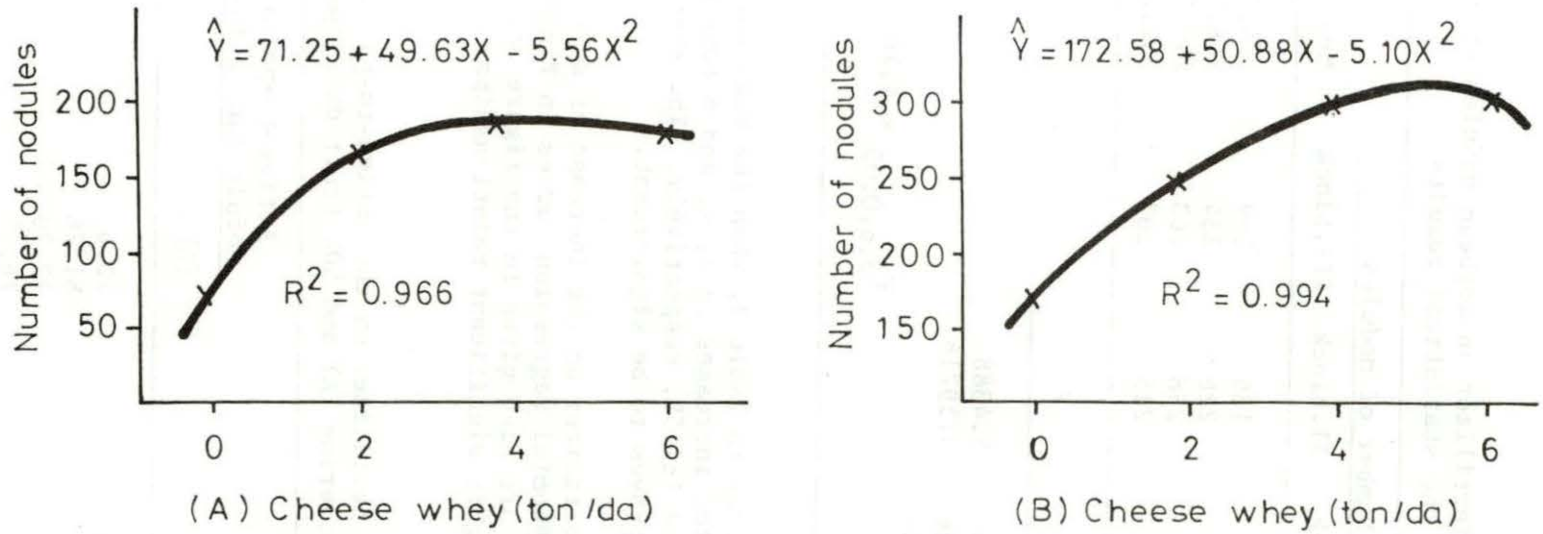

Table 5 summarizes the effect of whey as fertilizer on the levels of soybean production. Applications of 2, 4, and 6 tons of whey per decar increase the soybean yield from 141.7 kg/da to 184.4, 203.4 and 180.5 kg/da, respectively. Though the increases in yields are between 27.4-43.5%, the statistical variance analysis prove them to be insignificant, possibly due to the inconsistent variation figures in yields of treated parcels.

Table 5. Effect of whey as fertilizer on soybean yield

Whey applied	Soybean yields (kg/da)			Mean	Mean as %
	I. block	II.block	III.block		
0 ton/da (control)	150.	158.3	116.7	141.7	100.
2 tons/da	191.6	211.7	150.0	184.4	130.
4 tons/da	185.	191.7	233.3	203.3	143.5
6 tons/da	183.3	175.0	183.3	180.5	127.4

The increase in soybean yield was reasonable since 1 ton of whey as fertilizer would supply 1.5 kg N, 0.4 kg P and 1.5 kg K, as well as some Na, Ca, Mg, and Cl. On the other hand, the statistically significant increase in the nodules seems to be an important observation. Since soybean fixes air N into the soil by its "rhizobium" bacteria in the nodules, this observation of effect of whey as fertilizer on the increase of soybean nodules looks very encouraging and promising as a way to speed up or increase the enrichment of soil with N.

The mechanism of this increase in the number of nodules with whey as fertilizer is not quite clear. Maybe it has something to do with the rich lactic acid bacteria content and with fertilizer value of whey or the high biological oxygen demand (BOD) of whey which fits well with the "nif genes" being fond of less oxygen in the immediate vicinity (Tudge, 1983). Whatever the reason or mechanism for this increase in the nodules of soybean with whey as fertilizer, it seems to be well worth looking into.

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